SPECTRA OF GASES AT HIGH TEMPERATURES.

BY PROF. JOHN TROWBRIDGE, OF CAMBRIDGE, MASS.

(*Read April 4, 1902.*)

It seems to me highly appropriate that I should speak in Philadelphia, the home of Benjamin Franklin, on my researches in electricity, and that I should bring to the attention of scientific men here for the first time some remarkable results in the science in which Franklin was a pioneer.

In the Jefferson Physical Laboratory of Harvard University there is a Franklin electrical machine, which was ordered for the College by Franklin when he was one of the Commissioners in Paris. One can with great labor produce by means of it a thin spark perhaps one inch in length. In the same laboratory I have a storage battery of twenty thousand cells which, with suitable transformers, will generate a spark six and one-half feet in length, at a voltage of over six million.

In this practical age, especially in America, one is immediately asked, "What is the use of this great spark?" Probably a similar question was asked Franklin in regard to his smaller manifestations of electricity, and I shall ask you to reflect upon the developments of electricity since his time—the telegraph, the telephone, the lighting of cities, the trolley, the X-rays—and answer for me. You will remember, too, that Franklin, fearing ridicule, which we can charitably think generally arises from lack of imagination, tried his kite experiment in secret. I have not hesitated to build the largest electrical plant at present in existence for the scientific study of electricity, feeling sure that I could reach an unexplored field; and I hope that some of my results which I shall communicate to you will be considered of scientific importance, and will show that I have reached such a field. In the first place, Franklin would see in a spark six feet in length a veritable flash of lightning, brought out of the skies into a laboratory where it can be studied at all times and under almost any imposed conditions. I have discovered that these long sparks do not encounter, so to speak, any greater resistance in passing through the air than sparks one inch in length. The entire current used in propelling the electric cars in this city can pass along the path opened by these long sparks without suffering hardly an appreciable diminution. A rarified hole seems to be

bored, so to speak, in the air, through which, by means of water vapor, what we call electricity passes with a loud explosion. I wish to emphasize this fact in speaking of the scientific results which I have reached with this large electrical plant. I believe that I have proved that water vapor is essential for the passage of electricity through the air or gases. Just as a certain degree of moisture is necessary for chemical reactions, so is water vapor essential for the discharge of electricity through gases. I believe that we have never been able to obtain a perfectly dry gas; and if we should succeed in the future, such a gas would be a perfect electrical insulator.

Since the time of Franklin, the subject of spectrum analysis has been developed. He could study electricity only by means of his eyes. With the spectroscope, however, we now see instead of a blinding flash of white light, lights of many colors—in other words, a spectrum extending from red light to violet light, traversed by many bright lines which are due to the vibrations of the molecules of the components of the air. These molecules are invisible to us until revealed by electricity. The large storage battery I have had constructed enables us to explore a new field in electrochemistry, revealed by the motions of the smallest particles of matter in the world; particles which are everywhere about us, but are only evident when agitated by a discharge of electricity. I can surely claim to have subjected gases to the highest temperature that has been hitherto reached with this interesting result, that the spectra of oxygen, hydrogen, nitrogen, the main components of the air, contain the same spectrum, which is that of water vapor. By modification of the strength of the discharges, one can pass from the blue spectrum of argon to the red spectrum of this gas, which was discovered by Lord Rayleigh, even in tubes filled with hydrogen. This result is accomplished by a powerful dissociation of the small amount of air which is always present in glass tubes, even when great care is taken in preparing the hydrogen. I have obtained many such singular dissociations in hydrogen tubes which have been unsuspected.

Another important fact has been revealed by the passage of powerful discharges through glass tubes filled with rarified gases. I have discovered a rate of molecular vibration to which the photographic plate is apparently inactive. All gases give bright lines in their spectra, and consequently these bright lines are dark lines on the photographic negative. I have discovered dark lines in the

spectra of gases which give, therefore, bright lines on the negative; that is, they do not change the silver salt. This discovery, I think, is of great importance, for it shows that there are rates of vibration to which the photographic plate does not respond. It is imperfect in science as well as in art, and does not give a complete history of the stars, the temperatures of which are probably much higher even than those which I have reached. These dark lines are not due to what is called solarization or to absorption. The solar spectrum is thus probably far more complex even than we have supposed. This new field of what may be called destructive dissociation of gases in which I am working, promises to lead to many important results in the new science of electrochemistry.

[Prof. Trowbridge projected some lantern slides of the spectra of gases obtained with the discharges from the large storage battery, which showed the universal spectrum of water vapor and the remarkable dark lines of which he had spoken.—THE SECRETARIES.]

THE INFLUENCE OF ALCOHOLIC INTOXICATION UPON CERTAIN FACTORS CONCERNED IN THE PHENOMENA OF HÆMOLYSIS AND BACTERIOLYSIS.

A PRELIMINARY NOTE.

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In 1896 one of us (A. C. A.) published the results of an investigation upon the influence of alcoholic intoxication on resistance to infection.[1] In that paper attention was directed to the fact that the susceptibility of rabbits to certain types of infection was markedly increased through the influence of prolonged alcoholic intoxication. These results have been fully confirmed by others.[2]

At the time the results were published no fully satisfactory explanation of the mechanism of this phenomenon was available, though several suggestions were offered, viz., the reduced resistance may be referable to the local action of the alcohol upon the gastric mu-

[1] See *Journal of Exp. Med.*, 1896, Vol. i.

[2] See Laitinen, *Acta Societatis Scientiarum Fennicæ*, Tom. xxix, No. 7, 1900; also *Zeit. f. Hyg. u. Infektionskrankheiten*, 1900, Band 34, S. 206.